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DYNAMICS OF HOLM OAK (*QUERCUS ILEX* L.) LITTER DECOMPOSITION IN ISOLATED HABITATS, IN GRAPE-GROWING ECOSYSTEMS*

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SUMMARY

(original paper)

The losses of litter mass of Quercus ilex *L. were examined in isolated sites of grape-growing ecosystems in Southeastern France. The aim of this study is to compare and modeling litter mass loss in different conditions. The best model for describing litter decomposition was a quadratic regression (At2+Bt+C). Comparisons with other datas on mediterranean areas were made. The changes in litter mass loss with time showed that the influential factors are the area, the slope and the vegetation structure of the plots. The isolated sites with larger areas lost more litter mass owing to a good biological activity. This phenomenon is in addition to the slope effect, which stirs up the mass loss by leaching.*

KEY WORDS: Litter decomposition - Decay models - *Quercus ilex* - Provence - Isolated habitat - Agro ecosystem.

RÉSUMÉ

(travail original)

*DYNAMIQUE DE LA DÉCOMPOSITION DE LA LITIERE DE CHENE VERT (*QUERCUS ILEX *L.) DANS DES ILOTS DE VÉGÉTATION AU SEIN D'UN AGROSYSTEME VITICOLE. Les pertes de masse de la litière de chêne vert (*Quercus ilex *L.) ont été étudiées dans quelques habitats isolés au sein des agrosystèmes viticoles du Sud-Est de la France. Le but de ce travail est de comparer et de modéliser la dégradation de la litière dans différentes conditions. Le meilleur modèle mathématique de description de la décomposition de la litière de cet écosystème est la régression de type quadratique (At2+Bt+C). Des comparaisons ont été faites avec d'autres données sur des zones méditerranéennes. Les variations temporelles de la perte de masse ont montré que les facteurs les plus influants sont la surface, la pente et la structure de la végétation des sites d'étude. Les litières des habitats isolés à large surface ont des pertes de masse plus importantes induites par une meilleure activité biologique. Ce phénomène s'additionne à l'effet de la pente dont l'action favorise la perte de masse par lessivage.*

MOTS CLÉS : Décomposition de litière - Modèle de dégradation - Chêne vert - *Quercus ilex* - Provence - Habitat isolé - Agro écosystème.

INTRODUCTION

The rate of litter decomposition depends on biological and non-biological conditions, especially the chemical composition of the plant species that produce the litter, (RAPP, 1967; ANDERSON, 1973; MELILLO *et al.*, 1982; HERLITZIUS, 1983; GALLARDO & MERINO, 1993), biological activity (SEASTEDT & CROSSLEY, 1981) and climate, which directly influence the breakdown of the litter. That is the reason why this study attempts to compare and model litter mass loss in different ecological conditions. Holm oak litter decomposition has been compared to other data in mediterranean area (other sites, species and ecological conditions). In this case, modelling is a great mean firstly to appreciate litter decomposition in study sites and in other mediterranean sites, and secondly to predict decay efficiency.

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There is a maximal input of leaves to the soil during spring and autumn in the holm oak areas in the south of France (Billes *et al.*, 1975). Leaf decomposition is slow, taking three years to fully decompose fallen litter (Rapp, 1969; Gallardo & Merino, 1993), because of the toughness of the leaves that have a high tannin concentration. This substance is toxic for the mesofauna and some decomposers (Poinsot-Balaguer *et al.*, 1993), and reduce the mineralization of the leaves (Beck *et al.*, 1969 *in* Lemee & Bichaut, 1973).

Dryness slows biological processes, and hence the mass loss of litter, while rain increases it, by the acceleration of the biological activity and leaching of substances from litter (Vardavakis, 1988). An extra factor that could influence decomposition is the slope of sites which speed up mass loss by accelerating the leaching from litter (Gloaguen *et al.*, 1980).

The enzymes of microorganisms present in all stages of decomposition, even on the fresh leaves on trees (Perissol *et al.*, 1993), must slowly degrade tannic compounds before animals can begin to breakdown the leaves (Racon *et al.*, 1988).

In the occidental part of the Var department (Southeastern France), the anthropogenic pressure on the forest habitats is due mainly to the expansion of suburban areas of towns, road building, undergrowth clearing, and agricultural practices (market gardening and grape-growing).

The vineyards have divided up or even destroyed the local forest, and the forest area considerably reduced. Moreover, forest suffers from the disturbances made by viticulture: herbicides, pesticides, chemical fertilizers and introduction of non-forest species. These incursions have resulted in isolated forests (vegetation islets), survivors of a previous clearcutting, which have survived only because topography prevented vineyards being set up (steep slope, ditches, ridges, parcel limits…). This study examines the impact of isolated habitats with different environmental conditions (considered as insular ecosystems) on the decomposition of holm oak litter.

METHODS

The study was carried out on silicious type soil used for grape production since 1950 or earlier, in the west part of the Maures mountains (6°6' E; 43°1' N; 0-700 m above sea level). The criteria used to choose the experimental isolated plots were immediate proximity to vineyards, varying size of sites, presence of holm oak in all sites, presence of a control parcel near the islets (a large area of holm oak forest), short distance between sites (less than 1 km in order to keep the same climatic conditions and soil type). Five parcels of land were chosen (Tab. I). Parcels 3 and C (the control) were the steepest, largest and had a most forest type structure. Figure 1 gives the rainfall ocurring during the experimental period. The data are provided by a meteorological station 3 km from the study area.

Tableau I.– Description of study sites. *Description des sites d'étude.*

	Parcel 1	Parcel 2	Parcel 3	Parcel 4	Parcel C
Area (m^2)	1200	1300	19600	4050	94500
Length (m)	120	370	490	90	900
Width (m)	10	3,5	40	45	105
Slope (%)	0-10	0-10	30	0-10	20
Topography	Hedge between a path and a vineyard	Linear hedge flanked by two vineyards	Wide, sloping hedge in the middle of cultivated vineyards, South-East facing	Triangular islet near a house	Big, sloping forest stand North facing
Canopy (%)	60	20	80	70	90
Type of vegetation	*Quercus ilex* mixed with *Quercus pubescens*	*Q. ilex* with *Calycotome spinosa*	*Q. ilex* and *Quercus suber*. Undergrowth with *Ruscus aculeatus*	*Q. ilex, Pinus halepensis, Q. suber* and *Q. pubescens*	*Q. ilex* in majority Undergrowth with *R. aculeatus*
Other human activities	Clearcutting on the third of the length			Trampling	

The decomposition of holm oak litter (*Quercus ilex* L.) was studied by the litterbag method. Leaf litter was prepared by washing and drying fresh fallen leaves (for 24 h at 50°C) collected in May, on the ground of the control parcel. 5 g of leaves was then placed in a nylon bag with a surface area of one dm^2 and mesh of 5 mm. The bags were placed on June 1991 (time 0) on top of the original litter in the middle of each islet, under three holm oaks. Sampling took place every 50 days (apart from the first and last) during one year, and six bags were collected each time for each sites (6 samplings for the experiment period). After sampling, the bags were rinsed with 200 ml of water) and dried for 24 h at 50°C. The litterbag content was weighed immediately after drying to the nearest 1/l00 g. The Wilcoxon-Mann-Whitney test was used to compare the paired mass values remaining from the four sites and the control site at each sampling date. Each test was made with two series of 6 litter mass values.

The breakdown rate of the litter was analysed by 5 different models. The curves described by the change in the remaining mass were analysed using the following 5 mathematic models:

$y = y_0 e^{-kt}$ Model 1 (exponential)

$y = (At + B)/(t + C)$ Model 2 (rational)

$y = A + B \exp^{(kt)}$ Model 3 (asymptotic)

$y = A/(1 + B \exp^{(kt)})$ Model 4 (logistic)

$y = At^2 + Bt + C$ Model 5 (polynomial)

Legend: y = percentage of remaining mass; y_0 = percentage of initial litter mass; t = time in years; k = constant of annual decomposition (OLSON & CROSSLEY, 1973); A, B and C = equation coefficients.

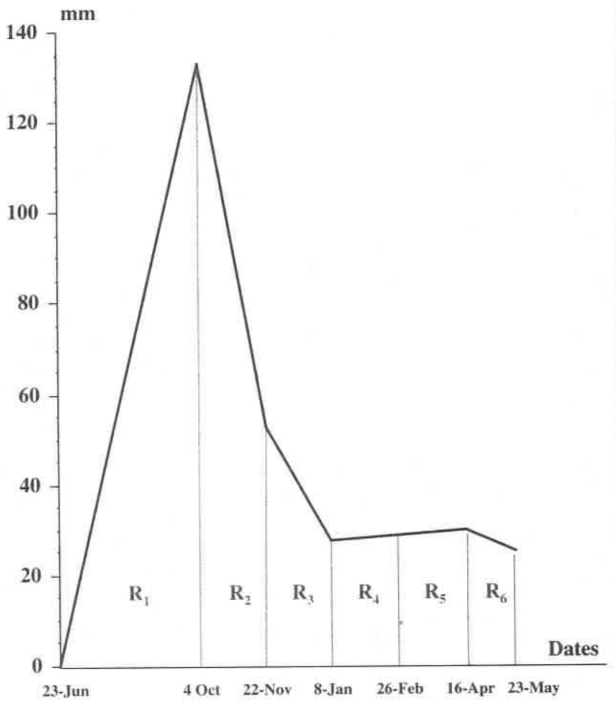

FIG. 1.– Rainfall (R) in mm in 1991 and 1992. For each sampling period, the accumulated amount of precipitation is given. For example, the area (R1) of section 1 (between 23 jun and 4 oct) corresponds to rain quantity during this period.

Précipitations cumulées (R) entre chaque prélèvement de sac de litière. Par exemple, la surface (R1) de la section 1 (entre le 23 juin et le 4 oct) correspond à la quantité de pluie (en mm) tombée durant cette période.

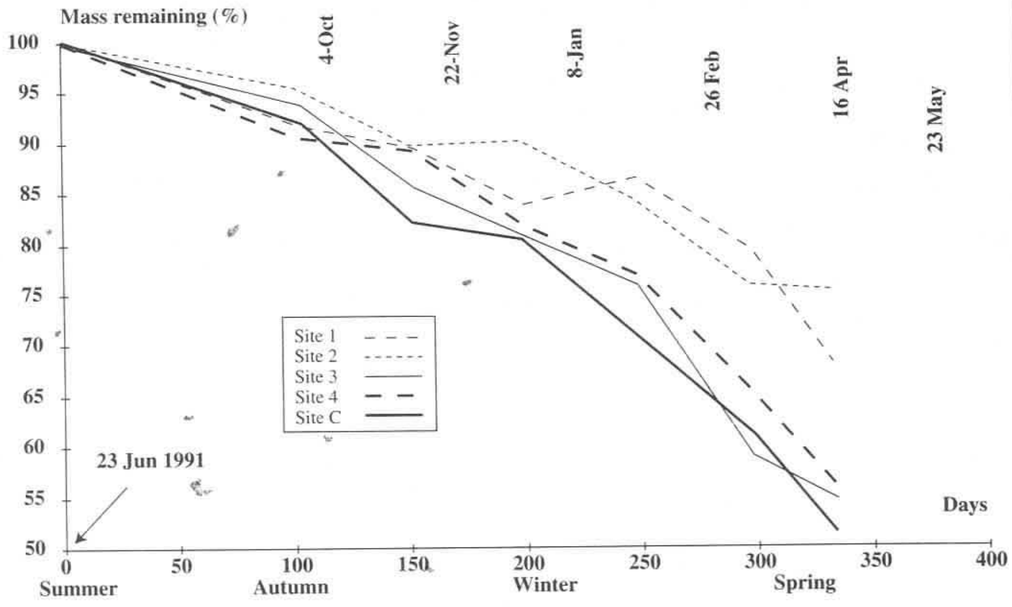

FIG. 2.– Remaining mass of leaf litter enclosed in litter bags, expressed as a percentage of the initial mass in the four sites and control site.

Variations de la masse des sacs de litière exprimée en pourcentage de masse restante dans les quatre sites et le site témoin.

The best model (differences between theorical model and experiment data series must be the smallest) will be used to calculate the quarter-life time ($t_{1/4}$ is the time required to lose 25% of the mass). The variability in the mass loss among litter bags is an other aspect of the decomposition process, described by the coefficient of variation: $C.V. = (100\ s/\chi)$ s = Standard deviation and χ = Mean mass of litter.

RESULTS

Figure 2 and table II, show that mass loss was low on all the plots after almost 4 months of decomposition (103 days), in spite of the high rainfall in September (FIG. 1): the highest loss amounted to only 10% at site 4. A higher mass loss was then observed, particularly at sites 3, 4 and C where the decomposition rate (k) increased regularly with time (FIG. 3; Table III for the WILCOXON-MANN-WHITNEY test). The sites were therefore divided into two groups: group n°1 included the smaller sites 1 and 2, and group n° 2 contained sites C, 3 and 4. The groups are statistically separated between 199th and 248th days of the experimental period (TAB. III). There was no significant difference in the overall mass loss of the two pools until day 248. Sites 3, 4 and C changed in the same way all times (3 = 4 = C), as did sites 1 and 2 (1 = 2). But plots 1 and 2 had significantly more remaining mass than plots 3, 4 and C from day 248 onwards (1 > 3; 1 > 4; 1 > C; 2 > 3; 2 > 4; 2 > C).

TABLEAU II.– Mean ± standard deviation (6 replicates) of remaining mass (%) in each sites.

Moyenne ± écart-type (des 6 répétitions) du pourcentage de masse restante au sein de chaque site.

DAYS	SITES				
	1	2	3	4	C
103	91,9 ± 3,8	95,5 ± 9,2	93,7 ± 5,1	90,6 ± 5,2	92,2 ± 4,0
152	89,6 ± 2,4	89,5 ± 2,7	85,5 ± 5,3	89 ± 5,7	82,2 ± 1,2
199	83,8 ± 4,7	90,1 ± 7,6	81,1 ± 2,9	82,2 ± 4,9	80,6 ± 4,5
248	86,5 ± 3,1	84,4 ± 5,0	75,9 ± 4,0	76,8 ± 7,5	71,9 ± 9,6
298	79,2 ± 4,3	76,1 ± 4,5	59,0 ± 5,5	64,6 ± 8,3	61,3 ± 6,0
334	68,1 ± 7,3	75,3 ± 4,5	54,8 ± 8,1	56,3 ± 8,3	51,4 ± 3,8

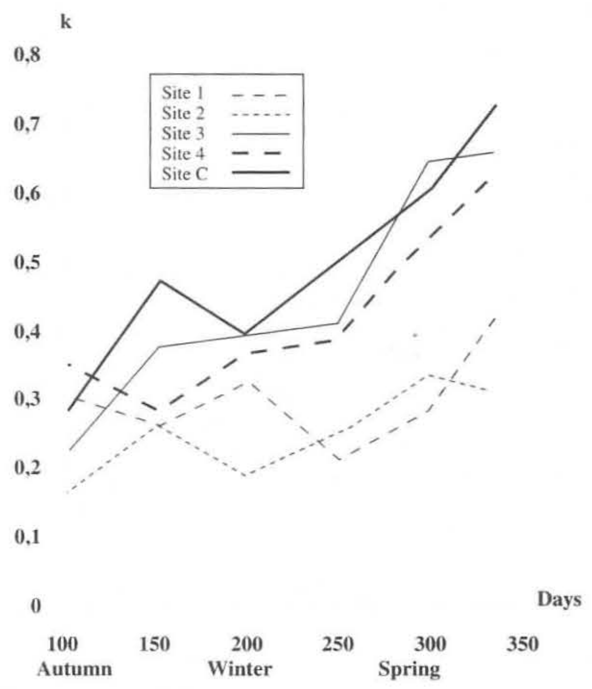

FIG. 3.– Change in decomposition constant (k) with time (days).
Variations du coefficient k de dégradation en fonction du temps.

TABLEAU III.– Two by two comparison of the sites by the WILCOXON-MANN-WHITNEY U-test. H_0: "The remaining masses of control site (C) were equal to those of the tested plots" H_1: "The remaining masses of control site (C) were smaller than those of the tested plots" H_0 is rejected if $P(U_{obs}) \leq$ Risk at 5% (P = 0,05).
Comparaison des sites deux à deux par le test U de WILCOXON-MANN-WHITNEY. Hypothèse H_0: "La masse restante du témoin (C) est égale à celle des sites testés" Hypothèse H_1: "La masse restante du témoin (C) est plus petite que celle des sites testés" H_0 est rejetée si $P(U_{0bs}) \leq$ Risque de 5% (P = 0,05)

DAYS	C/1	C/2	1/3	1/4	2/3	2/4	1/2	3/4	C/3	C/4
103	C = 1	C = 2	1 = 3	1 = 4	2 = 3	2 = 4	1 = 2	3 = 4	C = 3	C = 4
152	C < 1 p = 0,0039	C < 2 p = 0,0039	1 = 3	1 = 4	2 = 3	2 = 4	1 = 2	3 = 4	C = 3	C < 4 p = 0,0446
199	C = 1	C < 2 p = 0,0374	1 = 3	1 = 4	3 < 2 p = 0,037	2 = 4	1 = 2	3 = 4	C = 3	C = 4
248	C < 1 p = 0,0039	C < 2 p = 0,0065	3 < 1 p = 0,0039	4 < 1 p = 0,0103	3 < 2 p = 0,0163	4 < 2 p = 0,037	1 = 2	3 = 4	C = 3	C = 4
298	C < 1 p = 0,0039	C < 2 p = 0,0039	3 < 1 p = 0,0039	4 < 1 p = 0,0104	3 < 2 p = 0,0039	4 < 2 p = 0,0303	1 = 2	3 = 4	C = 3	C = 4
334	C < 1 p = 0,0106	C < 2 p = 0,0143	3 < 1 p = 0,0247	4 < 1 p = 0,025	3 < 2 p = 0,0103	4 < 2 p = 0,0105	1 = 2	3 = 4	C = 3	C = 4

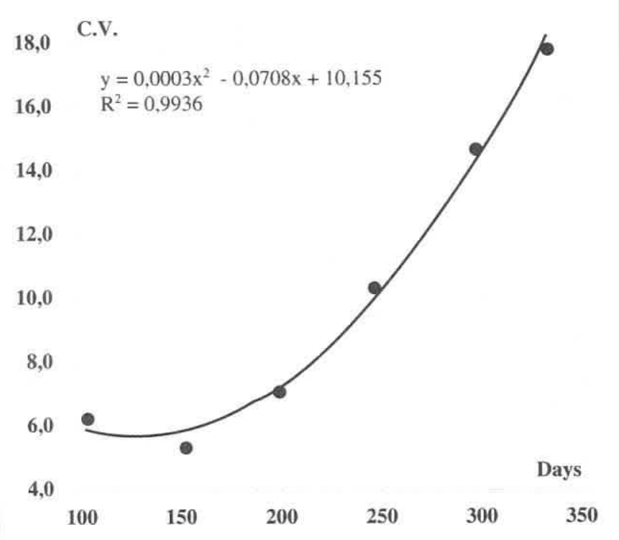

FIG. 4.– Change in mass loss for the individual bags for all parcels with time (days). Variability of mass loss expressed by the variation coefficient: C.V. = (l00 x Standard deviation) / mean.

Variations de la masse individuelle des sacs de litière pour toutes les parcelles en fonction du temps (jours). La variabilité des mesures de perte de masse est exprimée par le coefficient de variation : C.V. = (l00 x écart-type) / moyenne.

TABLEAU IV.– The standard deviation residues of each model.

Valeurs des écarts-types des résidus pour chaque modèle mathématique.

	SITES					MEAN
	1	2	3	4	C	
Model 1	3,45	2,379	5,198	4,666	4,692	4,077
Model 2	3,243	2,324	4,594	4,208	3,627	3,599
Model 3	3,297	2,175	4,225	3,825	3,647	3,434
Model 4	3,67	2,67	6,235	5,517	5,789	4,776
Model 5	3,793	2,056	2,603	1,961	2,203	2,523

TABLEAU V.– Quarter life time and correlation coefficient values of variables for the quadratic model (model 5).

Valeurs des temps de quart de vie et des coefficient de corrélation des variables pour le modèle quadratique (modèle 5).

Sites time (t1/4)	Quater-life coefficient (r)	Correlation
1	308	0,952
2	329	0,984
3	234	0,992
4	244	0,995
C	222	0,994

Site C tended to differ from site 2 after day 152 (site C has the greatest mass loss and the largest area in contrast to site 2, which was the smallest). The sites with large area, steep slope and dense undergrowth (sites 3, 4 and C) had the greatest mass loss suggesting a greatest biological activity. However, at site 4, decomposition was slightly less compared to sites 3 and C.

The coefficient of variation of the remaining masses from each sample event, for all the sites, used to compare the variability of the mass loss between the five plots (FIG. 4), increased regularly with time. In order to identify the factors responsible for the differences between sites, linear regressions were established between the remaining litter mass after one year of decomposition and some characteristics of the study sites: the area, the slope and the tree cover. There was a negative linear correlation between the remaining litter mass and the canopy cover of the sites ($r = - 0.95$; $p = 0.014$). This correlation may explain the faster mass loss at the control site (site C) which exhibits a higher evolution state of the vegetation structure (canopy density, shrub cover, height of vegetation).

The standard deviation of residues (i.e., the mean variation of remaining mass between theoretical and measured points) was calculated for each model and each site (TAB. IV), and define the best theorical decomposition process according to experiment data. The best equation is the one for which the mean standard deviation of residues is the smallest. The quadratic equation (or second degree polynomial), type $At^2 + Bt + C$ (model 5) fitted the data best (with $A = -4{,}296$ E-4; $B = 0{,}1003$; $C = 84{,}88$; $r^2 = 0{,}891$) while the logistic model (model 4) the least. We used therefore the polynomial model to calculate the quarter-life time of the litter for each one of the sites (TAB. V). Pool n° 2 has shorter $t_{1/4}$ and better correlation coefficients (r) than pool n° 1, confirming the more rapid breakdown on sites with high tree cover (TAB. 5). The mean $t_{1/4}$ for all the plots was 267 days.

DISCUSSION

The breakdown of holm oak leaf litter in the control site was higher than recently reported decay rates for other xerophilic Mediterranean oak species. In Italian *Quercus suber* forest (a sclerophyllous mediterranean oak very similar to *Quercus ilex*), VAN WESEMAEL (1993) obtained a mass loss of 40% and an k value of 0.47 after one year of decomposition. Over a 2-year period, GALLARDO & MERINO (1993) measured 34% to 52% mass loss in *Quercus suber* litter and 39% in *Quercus coccifera* litter. In Greek stands of this species, ARIANOUTSOU (1993) observed a mass loss ash-free dry mass of 33% in one year.

Some studies explain or predict breakdown as a function of climate and substrate quality (ABER & MELILLO, 1980). In Mediterranean areas, litter surface is subjected to severe summer dessication and very high temperature fluctuations. The leaves of sclerophyllous oaks are resistent to decomposition because of their toughness (GALLARDO & MERINO, 1993) and their tannin content which prevents attack by microfauna (SADAKA, 1986; POINSOT-BALAGUER *et al.*, 1993).

The values obtained by GROSJEAN & POINSOT-BALAGUER (1994) about the mass loss of *Quercus suber* in the same area for one year, are very similar to those obtained on Porquerolles island in a *Quercus ilex* forest by POINSOT-BALAGUER & LIVRELLI (1994). The mass loss was 12 - 19%, and k = 0.14. The mass loss and the decomposition rate of holm oak leaves are higher in our experiment, chiefly in pool 2, being up to 48.6% on the control site, for k = 0.70. This difference may be due to rainfall conditions especially the alternating dry and wet periods that occured three times during the experimental year (FIG. 1). There was a long dryspell in December following rainfall from September to November.

On the other hand, the increase variability of the mass loss (C.V.) with time for every site is attributed to the cumulative effects of variations in the microhabitat conditions. This was found earlier by TAKEDA (1988) for pine litter (*Pinus densiflora* Sieb. and Zucc.), by SEASTEDT *et al.* (1983) for *Quercus prinus* litter, and by FOGEL & CROMACK (1977) for Douglas litter (*Pseudotsuga menziensii* Mirb.). The initial heterogeneity of the environmental conditions is amplified as the litter bags get aged. Mass losses were low during the beginning of the experiment (corresponding to a dry period: july to september). There is little breakdown in summer in mediterranean areas because the drought prevents colonization by mesofauna and microflora (POINSOT, 1976; POINSOT-BALAGUER, 1989; PERISSOL *et al.*, 1993; ARGYROPOULOU *et al.*, 1993). The increase of the decomposition rate which occurred after the slow initial phase was probably related to leaching due to the strong autumn rainfall. After this period, the change in mass loss was different and two identical pools were identified (FIG. 2). A negative correlation was found between the tree canopy cover and the remaining litter mass. This indicates that stand characteristics such as canopy cover, may induce a climatic microheterogeneity between the experimental sites, distributed under the same general climatic conditions. The dense tree canopy at sites 3, 4 and C probably maintains soil humidity and reduced temperature fluctuations and evapotranspiration on the soil surface. These microclimatic parameters are assumed to improve the activity of microflora, inducing faster decomposition. It can be seen that site characteristics may thus counterbalance some negative factors such as sclerophylly and unfavourable seasonal climatic conditions (in summer and winter). A forest-type structure of the *Quercus ilex* stand increases the litter decay rate, presumably because of the a higher activity of soil microflora and microfauna due to better soil conditions. The holm oak forest decomposers seem to be more adapted to foliar substrate than vine-yard decomposers.

The difference in the responses of the plots can also be explained by the frequentation of the site. This has a considerable influence on degradation (as suggested by BLANDIN *et al.*, 1982). Plot 4 is situated near a house and suffers from the passage of walkers and hunters. The second is the presence of *Pinus halepensis* needles which are very low to be decomposed. GOURBIERE (1981) estimated that the decomposition and the incorporation of *Pinus* needles into the organic-mineral horizon takes ten years.

It can be noted however that the two sites with the lowest canopy cover (sites 1 and 2) also have the smallest surface. This suggests that the surface of the site indirectly influences the mass loss through a lower biological diversity and activity. Stands with low surface are probably more disturbed because having a more artificial structure and cannot sustained a good biological activity.

WIEDER & LANG (1982) have reviewed analytical approaches of the decomposition data. They concluded that the exponential models are fitting the decay data best (from both mathematical and biological points of view). They also stated that the double exponential model (and the asymptotic model closely related to the double exponential model) is particularly useful in experimental situations where the decomposition of a single type of litter is examined on several sites, as in our experiment. However, some authors have obtained better correlations with non-exponential models. Comparing several broadleaf trees, HOWARD & HOWARD (1974) observed that the best models for describing the breakdown of litter were the asymptotic function and the second degree function, followed by the exponential function. GLOAGUEN *et al.* (1980) found that the two functions which fitted the best for beech litter were the asymptotic and the second degree functions, while the best for the conifers were the asymptotic and the power functions. We found that the best model is the second degree function. This model can explain a total decaying of litter (0% remaining mass around 560 days after introducing litterbags in the sites). In contrast, the second degree function was found to be the worst for the smallest plots. However, it must be noticed that the mean values of the standard deviation residues (TAB. IV) were very close each other and also the five mathematical models we used. This is probably because the decomposition experiment took place during the first phase of the decomposition process as it was described by COUTEAUX *et al.* (1995) and which is an almost linear phase controlled by easily leachable compounds. The polynomial model seems to be more suitable for description of sclerophyllous leaves decomposition because the mass loss was stabilised at the beginning of process and increased progressively with time.

The results suggest the use of regularly increasing surfaces experimental plot to demonstrate the relationship between plots area, the environment and plant structures in studying the litter decay of a given species. Modelling of the litter decomposition can be used to define constants, for a certain type of environment that could be compared to those for other ecosystems (e.g. $t_{1/4}$, k, regression equation…).

This approach could help select typical islets before the beginning of certain human activities (agricultural or urban activities) and maintain a sustainable organic matter turnover in existing islets.

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VERSION FRANÇAISE ABRÉGÉE

Ce travail original traite de la dynamique de la perte de masse de la litière de chêne vert en situation d'habitats isolés. Ces habitats, constitués de bosquets de chênes verts, sont menacés par la pression humaine dans le cadre du défrichage au profit du vignoble varois. Dans l'optique de la conservation de ces habitats, l'essentiel de la démarche scientifique s'est orienté vers la comparaison et la modélisation de la perte de masse de la litière dans différentes conditions écologiques. Les différents modèles testés présentent l'intérêt de pouvoir être comparés avec ceux de la littérature et celui d'extrapoler la décomposition à long terme.

Les sites expérimentaux se situent dans le département du Var (France), sur les flancs Ouest du massif des Maures. Quatre d'entre eux sont des îlots de végétation de taille croissante ; le cinquième site (le témoin) est constitué par une chênaie verte d'environ un hectare. L'unité édaphique, climatique, agriculturale et végétale caractérise tous les sites et seules les microconditions écologiques et la surface changent d'un site à l'autre. La méthode d'étude de la perte de masse est celle des sacs de litière fréquemment employée dans la bibliographie. Les sacs de litière ont été disposés au pied des chênes de chaque îlot au mois de juin 1991 et sont constitués de feuilles de chêne vert prélevées dans le site témoin. La période d'expérimentation s'étale sur une année avec six prélèvements de sacs de litière dans chaque site. Cinq modèles mathématiques ont été testés et l'évolution de la variabilité de la perte de masse en fonction du temps a été calculée.

Les résultats montrent que le taux de dégradation de la litière (k) est très faible durant les trois premiers mois de l'expérimentation. Au delà, la perte de masse s'accélère et met en évidence une séparation des sites en deux groupes dont les valeurs de perte de masse sont statistiquement différentes entre le 199^e et le 248^e jour. Ce comportement dynamique s'explique dans sa première phase d'une part par la sécheresse estivale qui ralentit à la fois la colonisation de la faune du sol et le lessivage des substances hydrosolubles, et d'autre part grâce au caractère sclérophylle des feuilles de chêne vert riches en tannins. Les sites de plus grande surface, avec une pente prononcée et un sous-bois dense se révèlent être ceux qui ont la plus grande perte de masse, ce qui suggère une meilleure activité biologique, doublé d'un meilleur lessivage lors d'un automne particulièrement pluvieux. Par ailleurs, il existe une corrélation linéaire négative entre la masse restante de litière et le pourcentage de recouvrement de la canopée, ce qui montre l'impact de la structure de la végétation sur la décomposition de la litière. La canopée maintient une humidité plus importante, réduit les fluctuations de température au niveau du sol et limite l'évapotranspiration. De plus, la structure de végétation évoluée bénéficie de conditions édaphiques favorables à la faune du sol et à l'activité biologique. Les petits îlots présentent de faibles taux de dégradation de la litière probablement à cause de conditions écologiques plus difficiles au niveau du sol et d'un état de perturbation plus important (présence proche des vignobles). Ces sites ne peuvent alors maintenir une activité biologique importante.

La variabilité de la perte de masse augmente régulièrement avec la décomposition des feuilles, et semble être due à l'accumulation des micro-variations écologiques entre chaque site. Ces variations entre chaque sac de litière s'amplifient avec le vieillissement des feuilles.

Sur le plan de la modélisation, le meilleur modèle théorique (celui dont l'écart des résidus est le plus faible) est de type polynomial du second degré qui permet de calculer un temps de quart de vie de la litière (temps pour lequel 25 % de litière a disparu). Ce modèle permet d'extrapoler la décomposition totale de la litière (0 % de masse restante) aux alentours du 560^e jour. Par ailleurs, les coefficients de dégradation obtenus dans ce travail sont nettement plus forts que ceux observés par d'autres auteurs pour le chêne vert, probablement en raison de l'alternance de périodes humides et sèches (trois fois pour l'année).

Ainsi, la structure de végétation et la surface des îlots apparaissent comme les facteurs déterminants dans les processus de dégradation de la litière de chêne vert au sein des agrosystèmes viticoles de l'ouest des Maures. La modélisation a permis de définir un certain nombre de paramètres caractéristiques de ce type de litière. Elle permet la comparaison et la prévision à long terme du fonctionnement du recyclage de la matière organique, notamment dans le cadre de la protection des isolats de végétation (fonctionnement et biodiversité) dans ce contexte agricole si particulier.